Mini Project Report – Applied System Development Life Cycle and Software Testing

Trading Strategy Tester

L&T Technology Services

Document History

Ver. Rel. No.	Release Date	Prepared. By	Reviewed By	To be Approved By	Remarks/Revision Details
1	24/08/21	99005763	99005763	Patrick Andrews	
2	24/08/21	99005772	99005772	Patrick Andrews	
3	24/08/21	99005839	99005839	Patrick Andrews	
4	24/08/21	99005797	99005797	Patrick Andrews	
5	24/08/21	99005769	99005769	Patrick Andrews	
6	24/08/21	99005807	99005807	Patrick Andrews	
7	24/08/21	99005834	99005834	Patrick Andrews	
8	24/08/21	99005762	99005762	Patrick Andrews	
9	24/08/21	99005791	99005791	Patrick Andrews	
10	24/08/21	99005816	99005816	Patrick Andrews	

Introduction

1. There will always be differing opinions on how frequently to trade, how long to hold a position, and when to enter or exit the market. Our emotions influence our trading decisions as humans.
2. Rule Based Trading is the solution to this problem. Using a Rule Based Trading Style, one can back test the strategy and use it to make trade calls.
3. This Trading Strategy Tester will back test the strategy and make trading recommendations.

Features

This Trading Strategy Tester's various festivities include:

1. Can make buy and sell recommendations based on stock prices.csv document
2. Back testing the strategy on stocks is simple by downloading the.csv file from nseindia.com.
3. Provides the date and price at which the stock can be purchased and sold.

SWOT Analysis

4 W'S and 1'H

- **Who**

  This module targets the Retail Traders.

- **What**

  This utility is used to back test the rule based trading strategy.

- **When**

  This can be used if the retail trader wants to test a new trading strategy or check if the strategy works on a particular stock.

- **Where**

  This can be used in the stock market.

- **How**

  The utility can be used by giving a .csv file of any stock which can be easily downloaded from nseindia.com.

Detailed Requirements

High Level Requirements

ID	Description	Status
HR_01	Read .csv File	Implemented
HR_02	User should be able to choose a strategy for Backtesting	Implemented
HR_03	Trade calls	Implemented
HR_04	Backtest Performance parameters	Implemented
HR_05	Display Results	Implemented

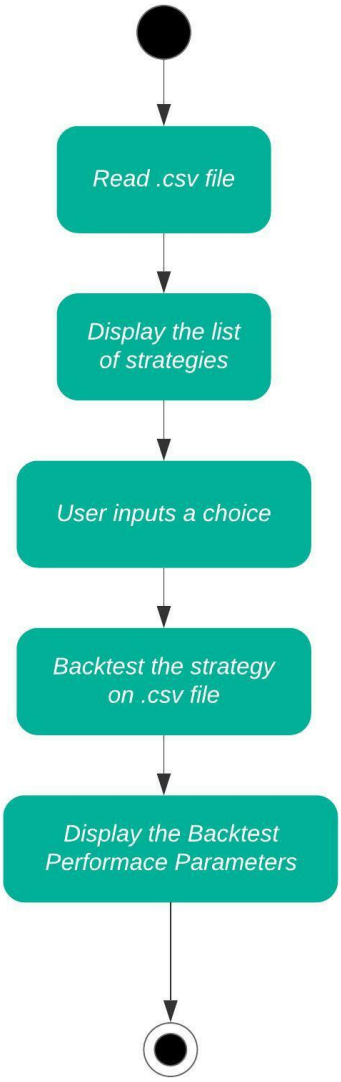
Low Level Requirements

ID	Description	Status
LR_01	To read Individual columns of .csv files	Implemented
LR_02	Implement Simple Moving Average strategy	Implemented
LR_03	Implement Moving Average Convergence Divergence strategy	Implemented
LR_04	Implement Rate of Change strategy	Implemented
LR_05	Implement Williams %R strategy	Implemented
LR_06	Implement Weighted Moving Average strategy	Implemented
LR_07	Implement Triangular Moving Average strategy	Implemented
LR_08	Implement Relative Strength Index strategy	Implemented
LR_09	Implement Money Flow Index strategy	Implemented
LR_10	Implement Exponential Moving Average strategy	Implemented
LR_11	Implement Bollinger Bands strategy	Implemented

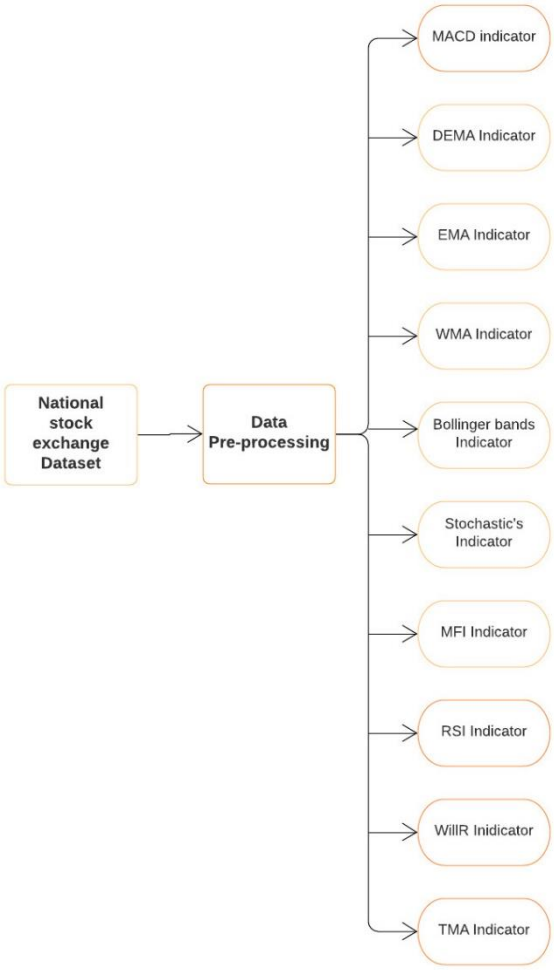
LR_12	Implement Stochastic Indicator	Implemented
LR_13	Buy to Buy Call	Implemented
LR_14	Sell to Sell Call	Implemented
LR_15	Price of Stock at particular date	Implemented
LR_16	Date at the Time of Buy or Sell	Implemented
LR_17	Total Profit/Loss %	Implemented
LR_18	Total Trades	Implemented
LR_19	Profit Factor	Implemented

Design & Architecture

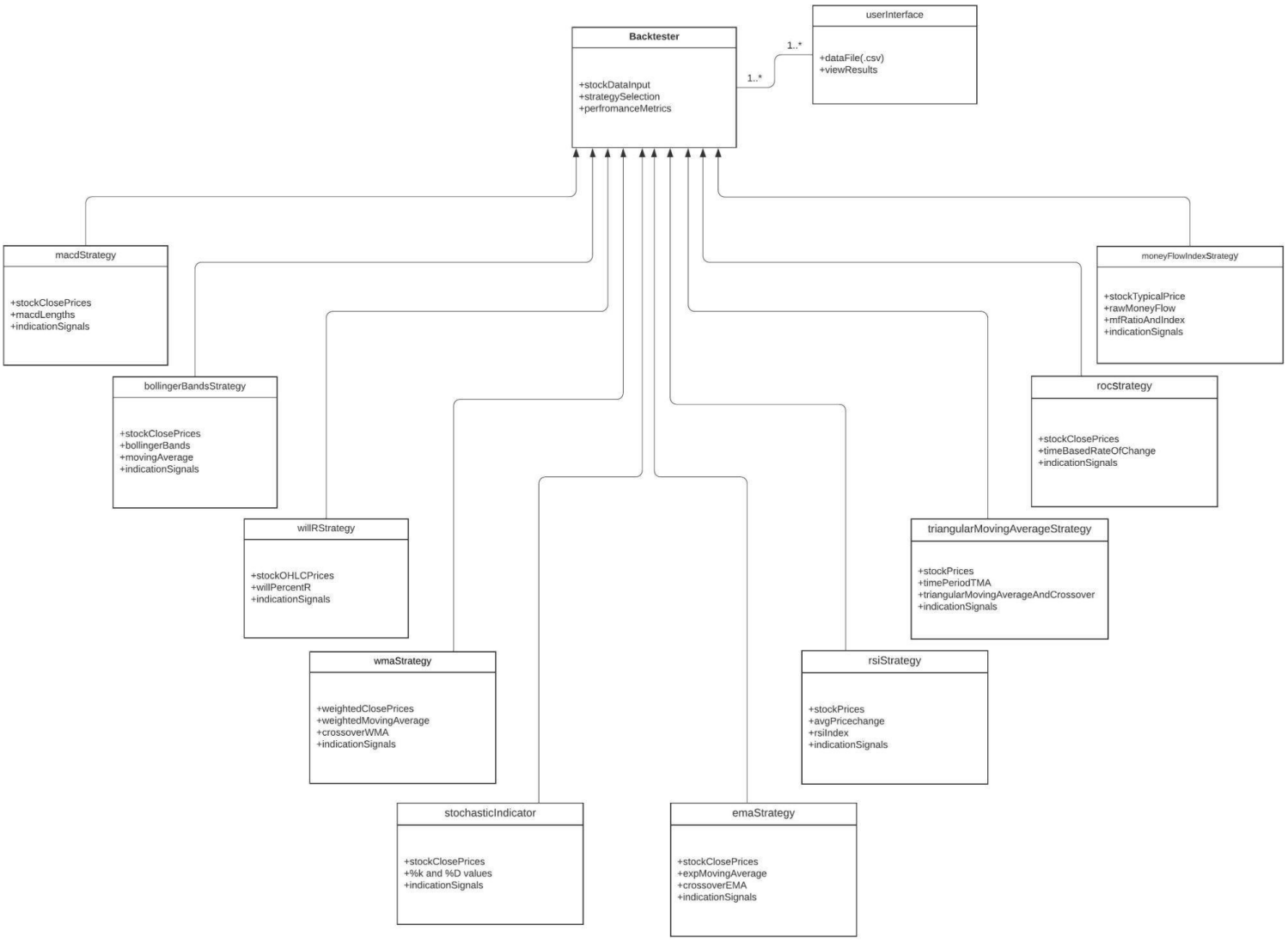
High Level Behavioral Diagram:



High Level Structural Diagram:

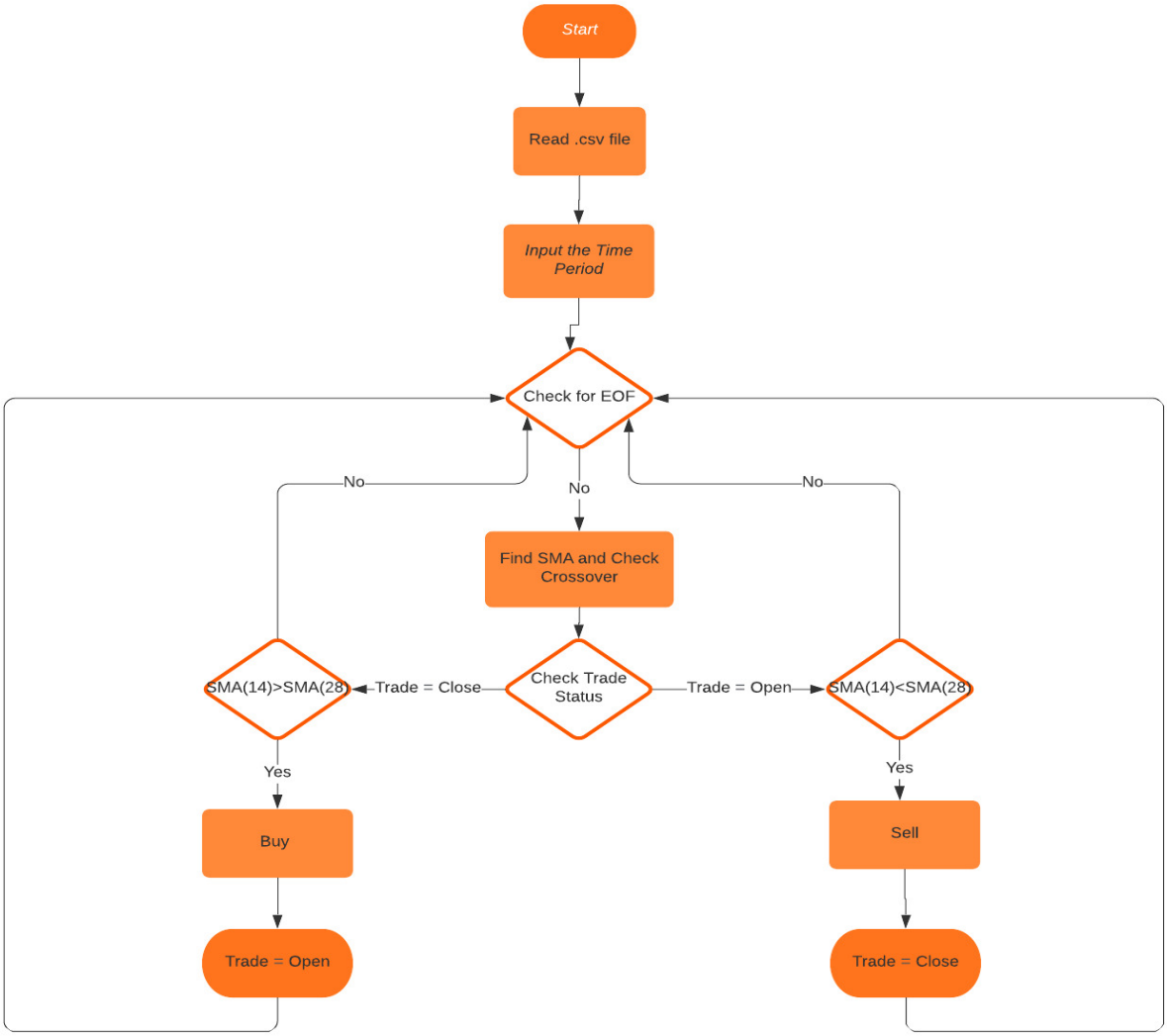


Low Level Structural Diagram



Different Strategies and Indicator:

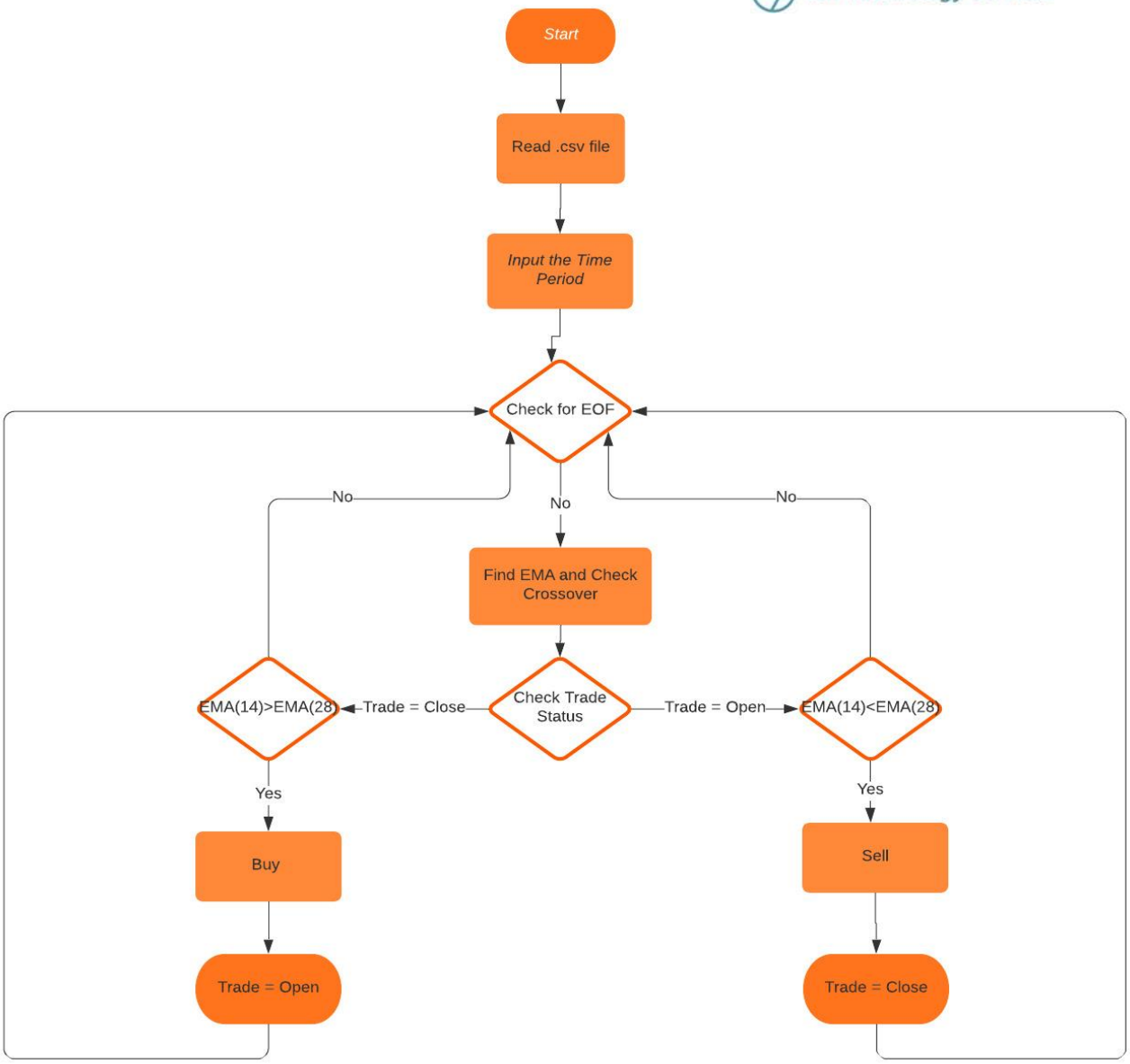
1. Simple Moving Average



$$SMA = (P[1] + P[2] + P[3] + \ldots P[N]) \div N$$

1. *N* is the number of periods in the SMA
2. .$P_{[N]}$ is the price being averaged (usually the closing price)

2.Exponential Moving Average



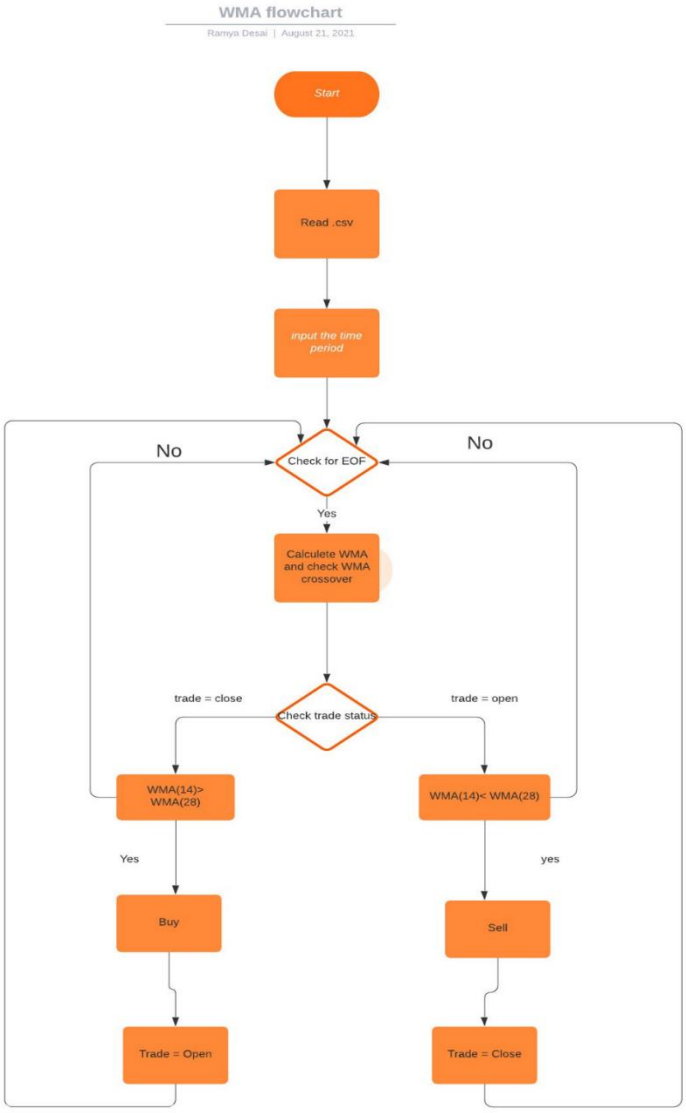
EMA = (closing price − previous day's EMA) × smoothing constant + previous day's EMA

where the smoothing constant is:

2 ÷ (number of time periods + 1)

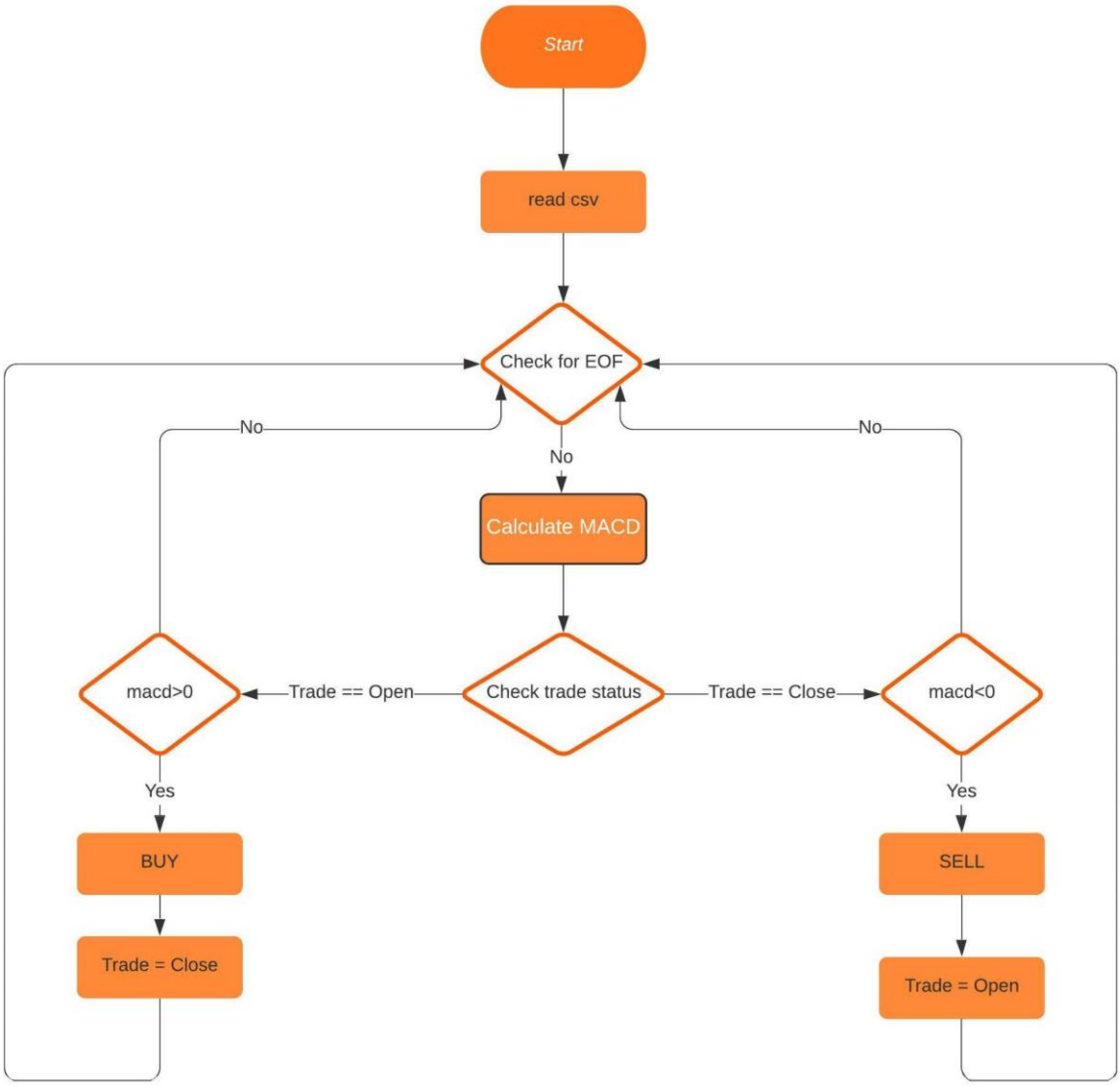
EMA=(closing price − previous day's EMA)× smoothing constant as a decimal + previous day's EMA

3.Weighted Moving Average



WMA = Price*n+ price*n+... Price(n) /n(n+1) /2

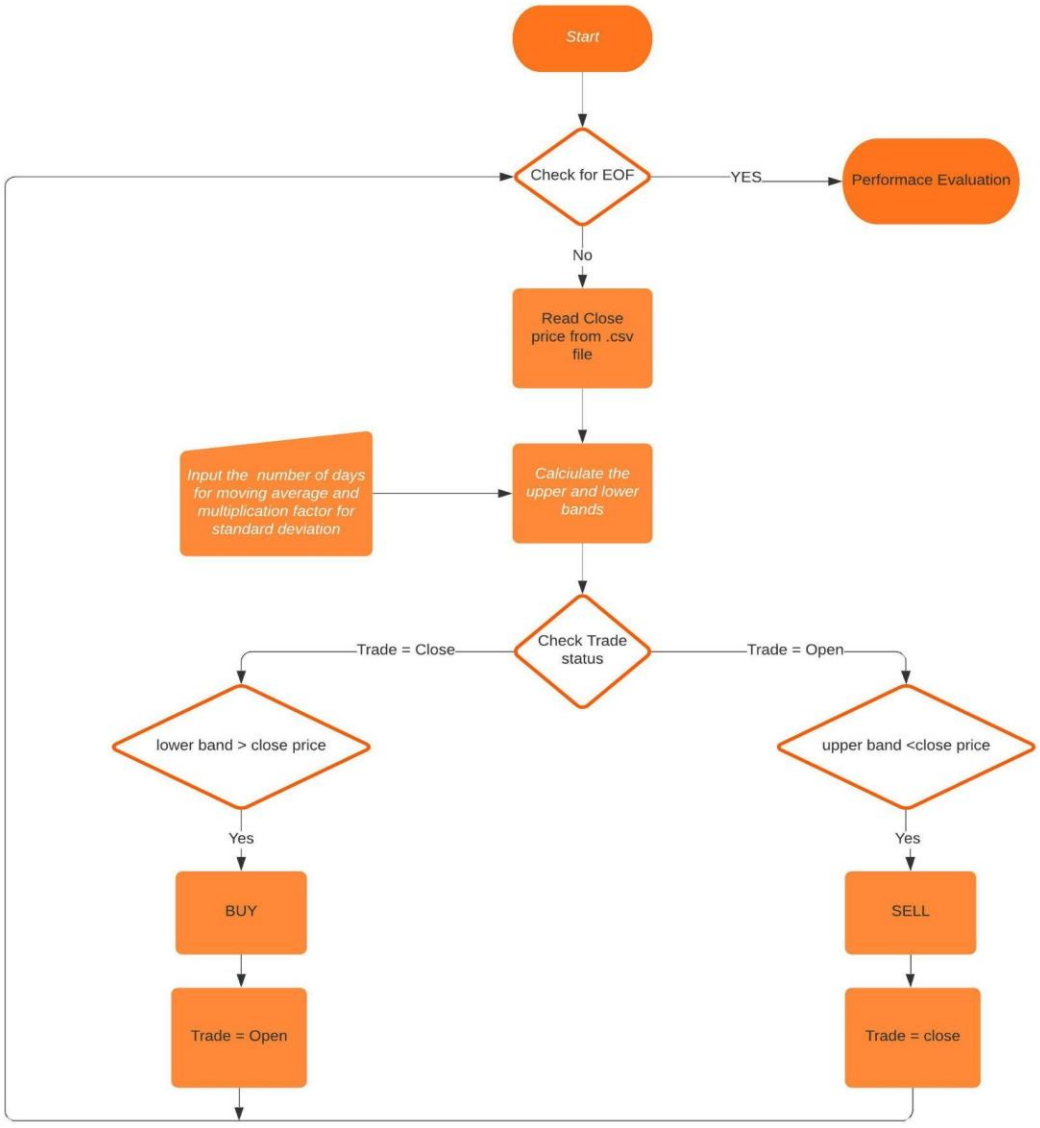
4.Moving Average Convergence and Divergence



Formula for MACD:

$$MACD = EMA(fast\ length) - EMA(slow\ length)$$

5.Bollinger Bands

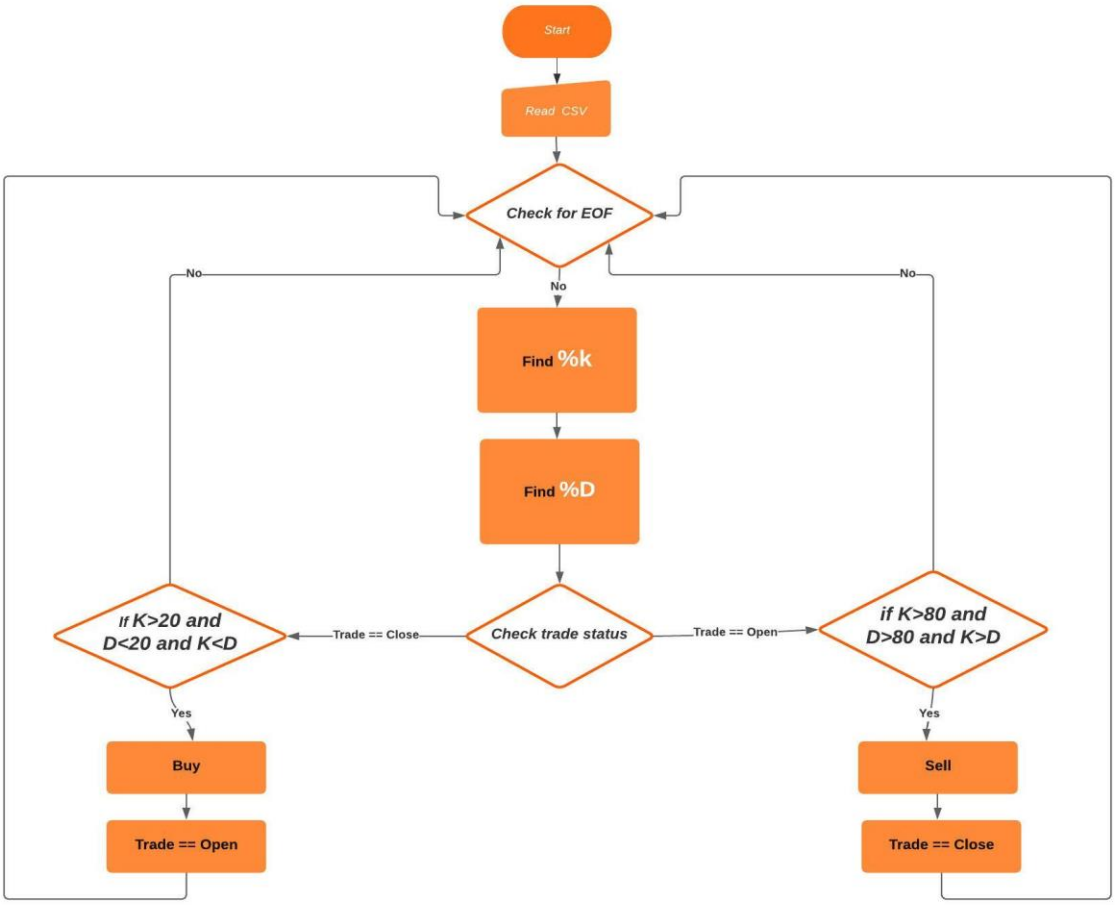


Formula for Bollinger band Indicator:

Upper Band= 20-period SMA + (20-day Standard Deviation of price x nDev)
Middle Band = 20-period SMA (Simple Moving Average)
Lower Band = 20-period SMA – (20-day Standard Deviation of price x nDev)

where 20 period SMA = 20 days Simple Moving Average (20 is variable component) and
nDev = number of standard deviation to be used(Typically 2 is used , can be 3, 4 or higher values)
For Default Values ,20 days and a factor of 2 is considered for implementation.

6.Stochastic Indicator

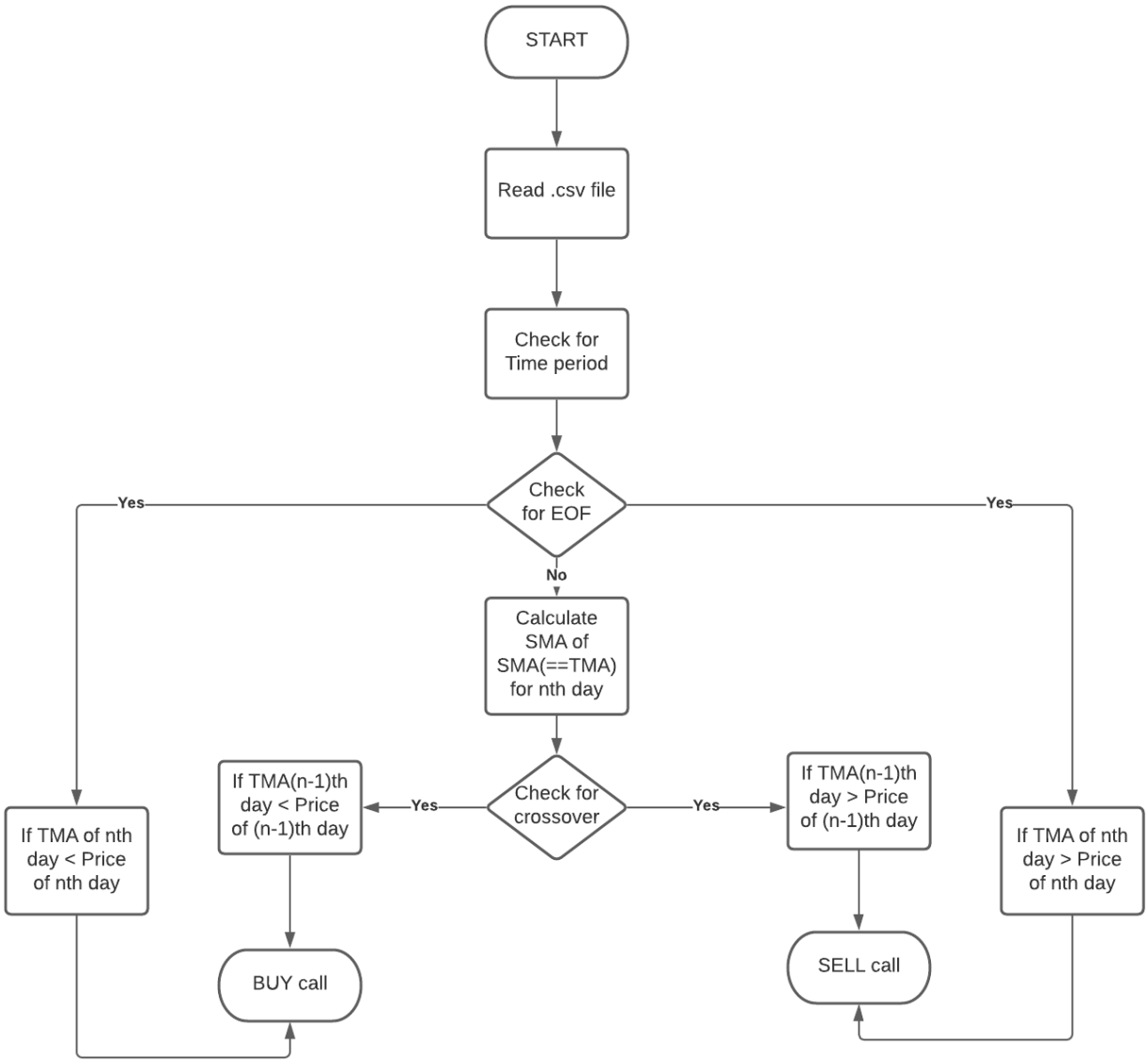


%K = (Current Close - Lowest Low)/(Highest High - Lowest Low) * 100

%D = 3-day SMA of %K

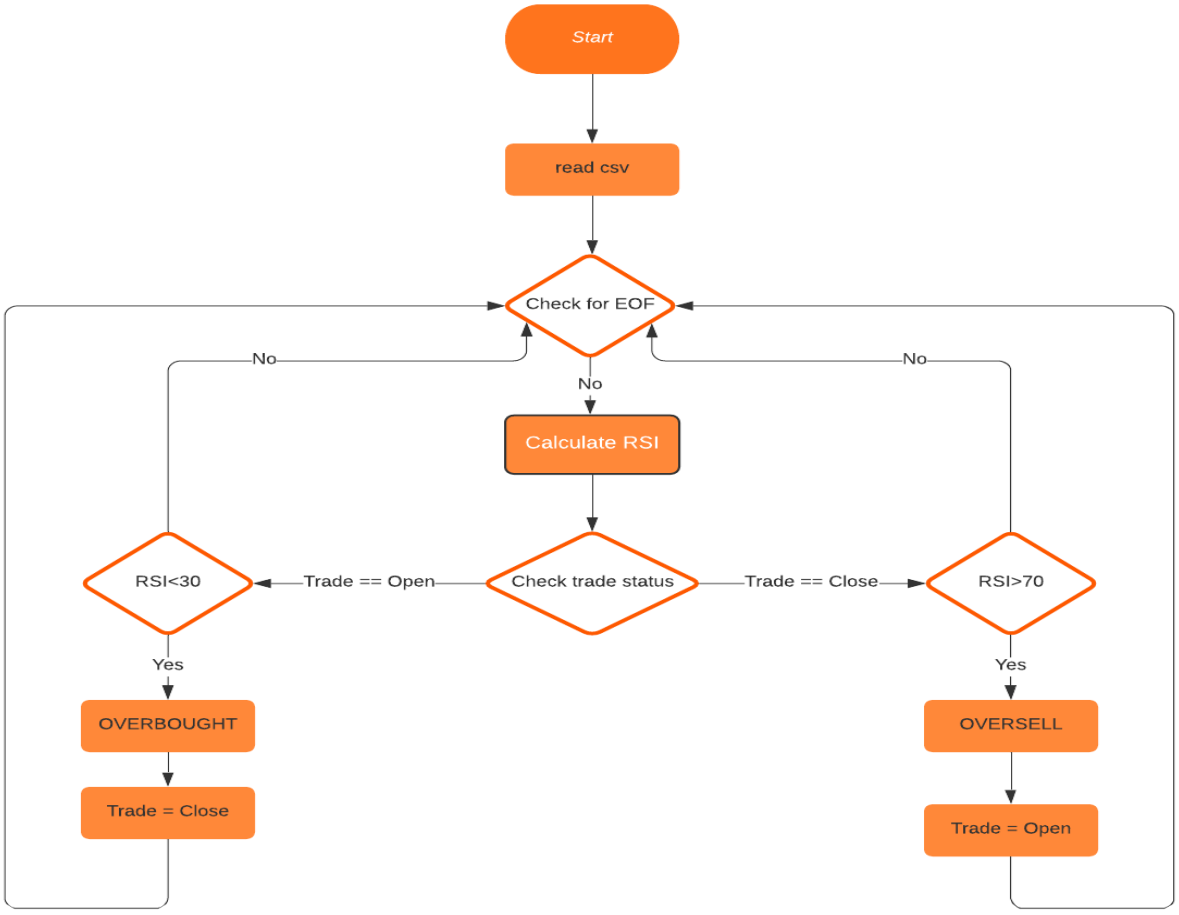
Lowest Low = lowest low for the look-back period.
Highest High = highest high for the look-back period.
%K is multiplied by 100 to move the decimal point two places.
The default setting for the Stochastic Oscillator is 14 periods.

7.Triangular Moving Average



TMA = SUM (SMA values)/ N Where N = the number of periods.

8.Relative Strength Index(RSI)



RSI = 100 – [100 / (1 + (Average of High Price Change / Average of Low Price Change))]

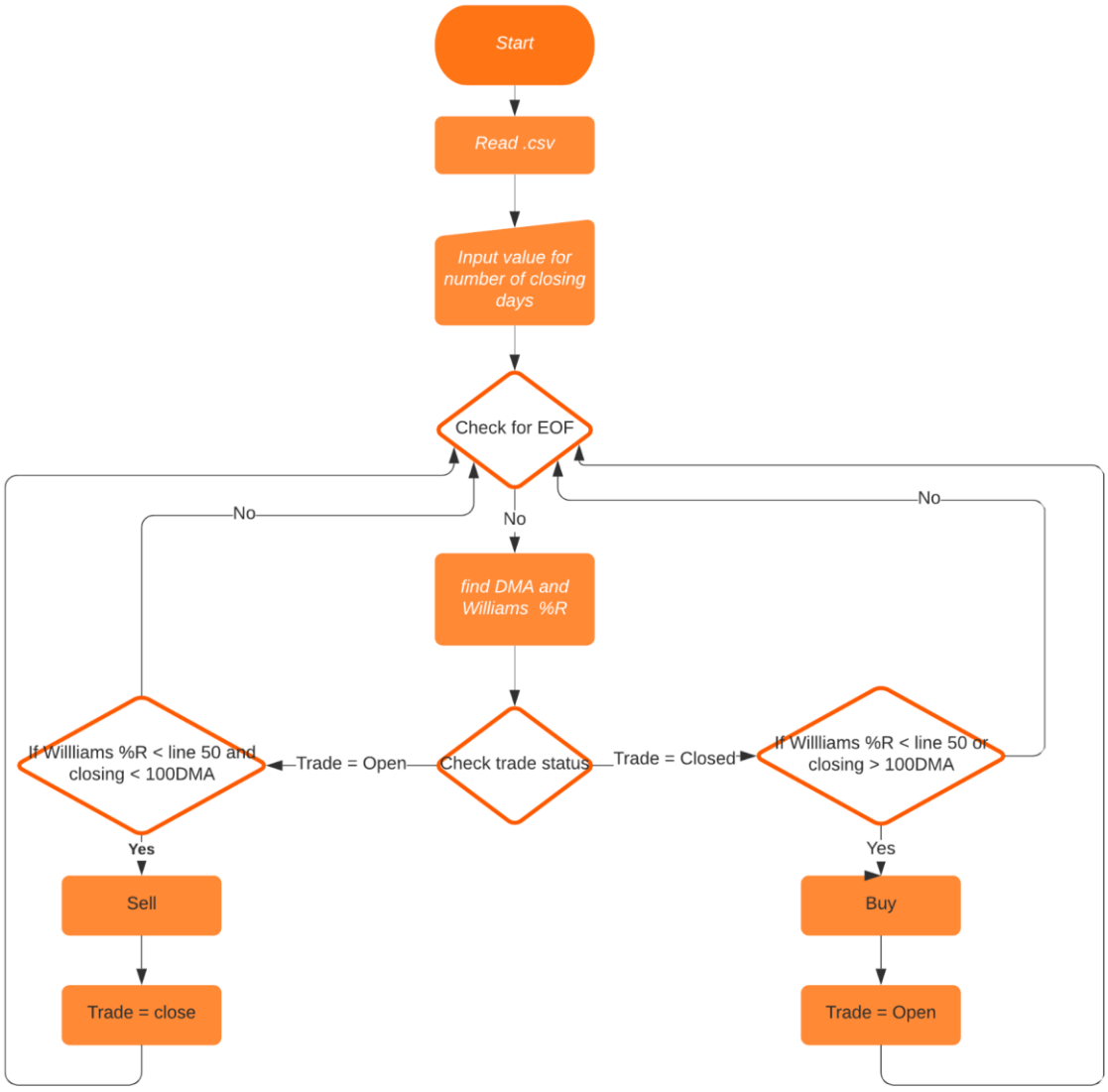
High price= from the high in csv file

Low price = from low in csv file

Average of high price = (sum of all high price/total number of high price)=sma(high price)

Average of low price = (sum of all low price/total number of low price) = sma(low price)

9.William %R

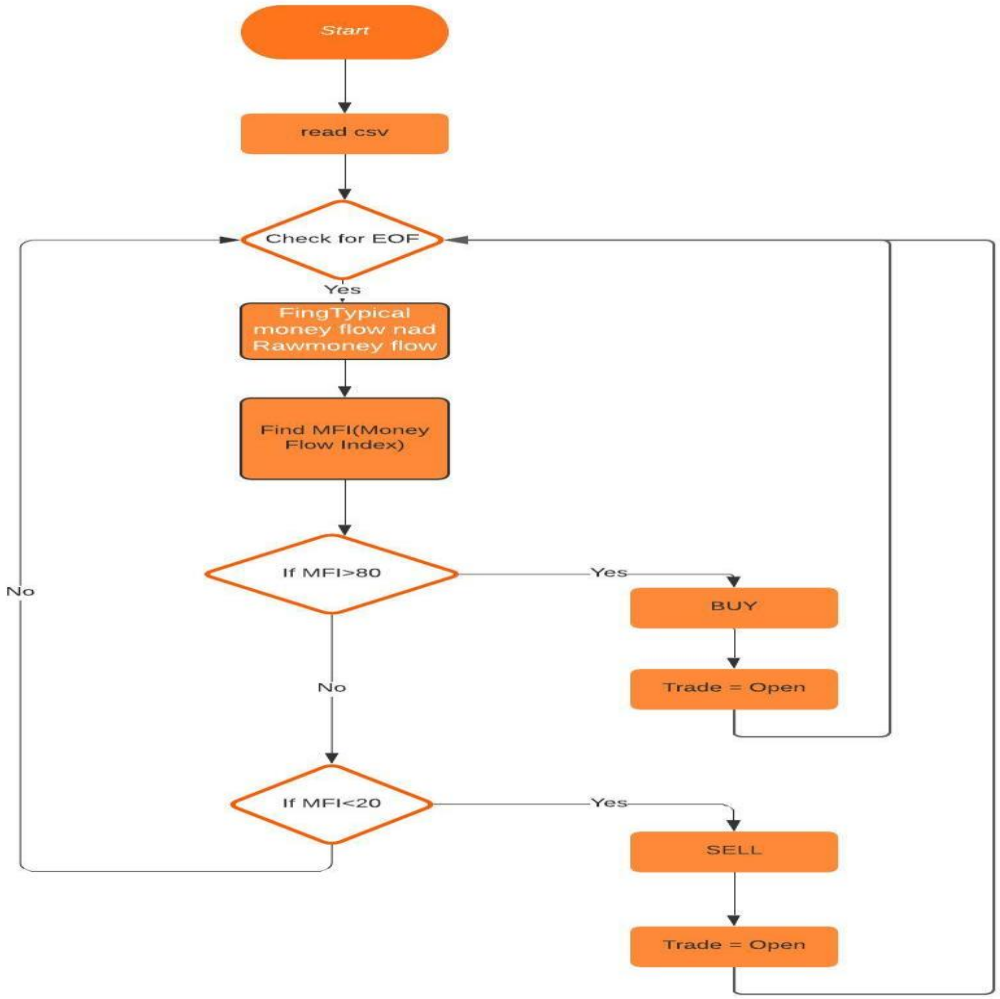


William%R = (Highest high -close) / (Highest high - Lowest low)

(Highest high and Lowest low taken for 14 days generally)

DMA(displaced moving average) for 100 days

10.Money Flow Index



Typical Money=(High+Low+close)/3

Raw Money=Typical money*Volume

Up/Down=1 (When current Typical Money > previous Typical Money)

Up/Down=0 (When current Typical Money < previous Typical Money)

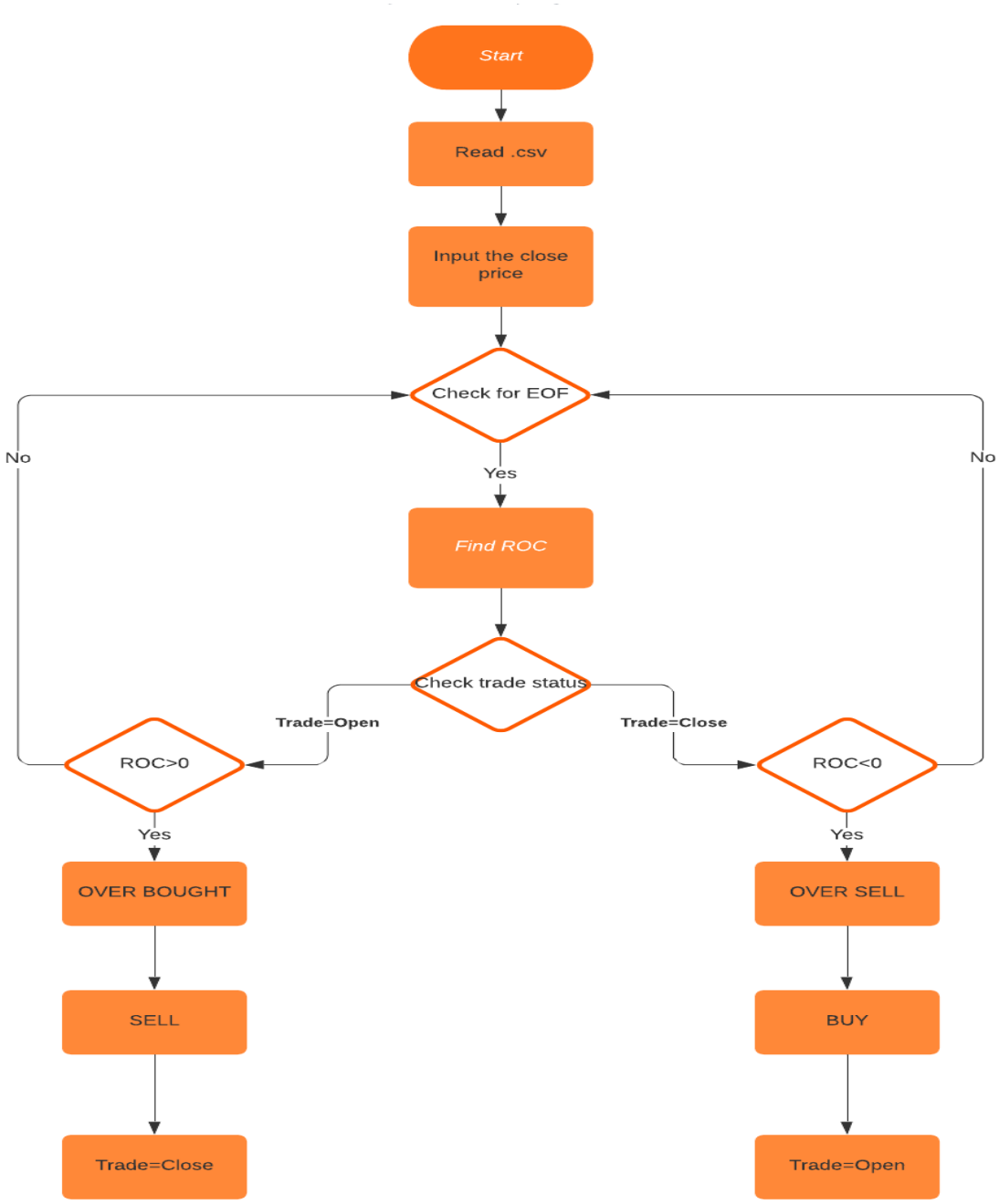
Positive 14 value= Sum of first 14 Raw money when Up/Down=1

Negative 14 value= Sum of first 14 Raw money when Up/Down=0

MFR= Positive 14 value/Negative 14 value

MFI= 100-(100/(1-MFI))

11.Rate of Change



ROC = [(Today's Closing Price – Closing Price n periods ago) / Closing Price n periods ago] x 100

Test Plan

Low Level Indicator

ID	Description	Expected input	Expected output	Actual output	Type of test
ID1	Indicator used in Exponential moving average	ema(26,10,close)	2776.48	PASS	Scenario based
ID2	Indicator used in William%R strategy	William%R(100,14,close{previous day,highOfLast14days,lowOfLast14days)	48.618	PASS	Scenario based
ID3	Indicator used in William%R strategy	DMA(100,close)	2718.1775	PASS	Scenario based
ID4	Indicator used in macd Strategy	macd(12,26,10,close)	70.93	PASS	Scenario based
ID5	Indicator used in rsi Strategy	rsi(14,10,high,low)	50.7496	PASS	Scenario based
ID6	Indicator used for Bollinger Bands Strategy	upperBand(2,20,361,close)	1774.471	PASS	Scenario based
ID7	Indicator used for Bollinger Bands Strategy	lowerBand(2,20,361,close)	1469.00298	PASS	Scenario based
ID8	Indicator used for Triangular Moving Average Strategy	TMA-Triangular Moving Average(26,10,close)	2798	Not updated	Scenario based
ID9	Indicator used in ROC strategy	roc(20,10,close)	6.4407	FAIL	Scenario based
ID10	MFI Indicator	mfi(ArrayName)	78.1977	PASS	Scenario based
ID11	Indicator used in Weighted moving average Strategy	WMA(10,20,close)	2096.5	FAIL	Scenario based
ID12	Stochastic Oscillator	funforK(14,369,close,HIGH,LOW)	64.3270	FAIL	Scenario based

Low Level Strategy Plan

ID7	MFI Indicator	Data from .csv file	Buy When MFI<20 Sell When MFI>80	As expected	Scenario based
ID8	wmaStrategy	Data from .csv file	Buy when WMA(14)>WMA(28) Sell when WMA(14) <WMA(28)	As expected	Scenario based
ID9	Stochastic	Data from .csv file	If K<20 && D<20 && K<D --> BUY ; IF K>80 && D>80 &&K>D --> SELL	As expected	Scenario based
ID10	RSI Strategy	Data from .csv file	If RSI<30 --> BUY ; IF RSI>70 --> SELL	As expected	Scenario based

High Level Strategy Plan

Description	Expected input	Expected output	Actual output	Type of test
Input data	.csv file from NSE	Read and identify values for close,high low etc.	Read and identify data from .csv file	technical
Select strategy	User select options only from the displayed options	Performance parameters of selected strategy	Performance is calculated and displayed	technical

Boundary Based Test Plan

Description	Expected input	Expected output	Actual output	Type of test
Path to the input data	.csv file in 3_Implementation folder	File path will be detected	PASS	Boundary
Path to the input data	.csv file not present in 3_Implementation folder	Invalid error message will be displayed	PASS	Boundary
Input file name	Filename.csv	Valid input and list of strategies must be displayed	PASS	Boundary
Input file name	anything else other than Filename.csv	Invalid error message will be displayed and user will be prompted to enter the valid filename	PASS	Boundary
Selection of strategies from the displayed list	Input of numbers 1 to 11	User input gets accepted	PASS	Boundary
Selection of strategies from the displayed list	any input other than numbers from 1 to 11	Invalid error message will be displayed and user will be prompted to enter the valid number	PASS	Boundary
Prompt to execute the strategy either with default/External Input Values	Input of number 1	Strategy is executed with default values	PASS	Boundary
Prompt to execute the strategy either with default/External Input Values	Input of number 2	User will be prompted to enter the input based on choosen strategies	PASS	Boundary
Prompt to execute the strategy either with default/External Input Values	any input other than 1 or 2	Invalid error message will be displayed and user will be prompted to enter a valid number	PASS	Boundary
External input of Parameters for strategies	a number between 1 to 500	User input is accepted	PASS	Boundary
External input of Parameters for strategies	any input other than numbers from 1 to 500	Strategies Executed with default values	PASS	Boundary

Implementation Screenshots

Working of the Program:

Case 1:

```
                    * Please use the .csv files in "3_Implementation" folder *
                                            OR
* Download .csv file of any share of your choice from "nseindia.com" in "3_Implementation" folder *

Write the name of file as "File Name".csv : LTTS.csv

Select a strategy from the given options

1.Simple Moving Average
2.Bollinger Bands
3.Stochastic
4.Money Flow Index
5.Exponential Moving Average
6. Weighted Moving Average
7.MACD
8.rsi
9.William%R
10.Rate Of Change
0.Exit

Enter your choice: 2

The values for moving average of close prices and standard deviation as well as multiplication factor of upper and lower bands are required.

1.Default Values
2.External Input
Please enter a choice :1
Trade   Status          Date                    Price           P/L

1       BUY             28-Jan-2020             1693.30
        SELL            29-Jan-2020             1728.85         35.55

2       BUY             30-Jan-2020             1689.15
        SELL            31-Jan-2020             1679.25         -9.90

3       BUY             01-Feb-2020             1666.05
        SELL            03-Feb-2020             1640.90         -25.15

4       BUY             04-Feb-2020             1699.85
        SELL            05-Feb-2020             1695.00         -4.85

5       BUY             06-Feb-2020             1672.20
        SELL            07-Feb-2020             1687.85         15.65
```

```
152     BUY             08-Jun-2021             2784.30
        SELL            09-Jun-2021             2738.60         -45.70

153     BUY             10-Jun-2021             2810.00
        SELL            11-Jun-2021             2873.80         63.80

154     BUY             14-Jun-2021             2863.25
        SELL            15-Jun-2021             2859.45         -3.80

155     BUY             16-Jun-2021             2844.55
        SELL            17-Jun-2021             2808.20         -36.35

156     BUY             18-Jun-2021             2794.60
        SELL            21-Jun-2021             2806.55         11.95

157     BUY             22-Jun-2021             2824.25
        SELL            23-Jun-2021             2825.20         0.95

158     BUY             24-Jun-2021             2854.65
        SELL            25-Jun-2021             2927.05         72.40

159     BUY             28-Jun-2021             2885.45
        SELL            29-Jun-2021             2892.75         7.30

160     BUY             30-Jun-2021             2903.10
        SELL            01-Jul-2021             2892.60         -10.50

161     BUY             02-Jul-2021             2877.20
        SELL            05-Jul-2021             2899.90         22.70

162     BUY             06-Jul-2021             2893.50
        SELL            07-Jul-2021             2921.75         28.25

163     BUY             09-Jul-2021             2954.00
        SELL            12-Jul-2021             2917.55         -36.45


|| Total Trades: 162 || || Profitable Trades percentage: 50.00 % ||     || Total P/L: 524.65 || || Profit Factor: 1.22 ||

The Performance of the strategies on historical data is just a probable indication but final decision of Trade is subject to personal discretion!!
```

Case 2:

```
Select a strategy from the given options

1.Simple Moving Average
2.Bollinger Bands
3.Stochastic
4.Money Flow Index
5.Exponential Moving Average
6. Weighted Moving Average
7.MACD
8.rsi
9.William%R
10.Rate Of Change
0.Exit

Enter your choice: 1

Two different number of days are required for simple moving average calculations.

1.Default Values
2.External Input
Please enter a choice :2

Enter two different number of days for simple moving average :12 24
Trade   Status          Date                    Price           P/L

1       BUY             01-Feb-2020             1666.05
        SELL            05-Mar-2020             1638.50         -27.55

2       BUY             22-Apr-2020             1178.60
        SELL            08-May-2020             1167.40         -11.20

3       BUY             04-Jun-2020             1279.10
        SELL            03-Jul-2020             1295.10         16.00

4       BUY             10-Jul-2020             1411.70
        SELL            02-Sep-2020             1528.90         117.20

5       BUY             18-Sep-2020             1673.05
        SELL            09-Nov-2020             1720.20         47.15

6       BUY             27-Nov-2020             1723.20
        SELL            03-Feb-2021             2565.90         842.70
```

```
1.Default Values
2.External Input
Please enter a choice :2

Enter two different number of days for simple moving average :12 24
Trade   Status          Date                    Price           P/L

1       BUY             01-Feb-2020             1666.05
        SELL            05-Mar-2020             1638.50         -27.55

2       BUY             22-Apr-2020             1178.60
        SELL            08-May-2020             1167.40         -11.20

3       BUY             04-Jun-2020             1279.10
        SELL            03-Jul-2020             1295.10         16.00

4       BUY             10-Jul-2020             1411.70
        SELL            02-Sep-2020             1528.90         117.20

5       BUY             18-Sep-2020             1673.05
        SELL            09-Nov-2020             1720.20         47.15

6       BUY             27-Nov-2020             1723.20
        SELL            03-Feb-2021             2565.90         842.70

7       BUY             04-Feb-2021             2618.90
        SELL            08-Feb-2021             2700.55         81.65

8       BUY             09-Feb-2021             2668.70
        SELL            05-Mar-2021             2622.65         -46.05

9       BUY             10-Mar-2021             2759.95
        SELL            26-Mar-2021             2548.65         -211.30

10      BUY             09-Apr-2021             2911.85
        SELL            29-Apr-2021             2628.15         -283.70

11      BUY             28-May-2021             2705.25

|| Total Trades: 11 ||  || Profitable Trades percentage: 45.45 % ||     || Total P/L: 524.90 || || Profit Factor: 1.911 ||


The Performance of the strategies on historical data is just a probable indication but final decision of Trade is subject to personal discretion!!
```

Unit Testing

```
build/Test_TradingStrategy.out
test/Test.c:33:testSma:PASS
test/Test.c:34:testBollingerBands:PASS
test/Test.c:35:testMFI:PASS
test/Test.c:36:testmacd:PASS
test/Test.c:37:testWilliamR:PASS
test/Test.c:38:testroc:PASS
test/Test.c:39:testrsi:PASS
test/Test.c:40:testEma:PASS
test/Test.c:41:testfindLength:PASS

-----------------------
9 Tests 0 Failures 0 Ignored
OK
sourav@DESKTOP-T9LDRA3:/mnt/c/Users/sroha/Downloads/team15-SDLC-AUG_Batch-main/3_Implementation$
```

Valgrind Check for external input:

```
Closing Program.....
==2418==
==2418== HEAP SUMMARY:
==2418==     in use at exit: 0 bytes in 0 blocks
==2418==   total heap usage: 657 allocs, 657 frees, 323,048 bytes allocated
==2418==
==2418== All heap blocks were freed -- no leaks are possible
==2418==
==2418== For lists of detected and suppressed errors, rerun with: -s
==2418== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
```

Valgrind Check on test cases:

```
test/Test.c:33:testSma:PASS
test/Test.c:34:testBollingerBands:PASS
test/Test.c:35:testMFI:PASS
test/Test.c:36:testmacd:PASS
test/Test.c:37:testWilliamR:PASS
test/Test.c:38:testroc:PASS
test/Test.c:39:testrsi:PASS
test/Test.c:40:testEma:PASS
test/Test.c:41:testfindLength:PASS

-----------------------
9 Tests 0 Failures 0 Ignored
OK
==2474==
==2474== HEAP SUMMARY:
==2474==     in use at exit: 0 bytes in 0 blocks
==2474==   total heap usage: 9 allocs, 9 frees, 4,448 bytes allocated
==2474==
==2474== All heap blocks were freed -- no leaks are possible
==2474==
==2474== For lists of detected and suppressed errors, rerun with: -s
==2474== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
```

Badges

Build	Code Quality	Unity	Git Inspector
Linux C/C++ CI passing Windows C/C++ CI passing	Code Quality - Static Code - Cppcheck passing Valgrind passing	Unit testing passing	Contribution Check - Git Inspector passing

Contribution List - Git Inspector

Author	Commits	Insertions	Deletions	% of changes
2015pushkar	23	371	47	5.23
Alna	19	592	200	9.91
Kunal Mozarkar	11	149	74	2.79
RAJIV ADAK	6	59	7	0.83
Rekha-csv	16	490	104	7.43
Shreyasi2059	10	68	29	1.21
Sourav	19	405	109	6.43
The-lana	13	28	97	1.56
aashi291	30	171	221	4.90
abhaysahu10	40	4472	162	57.98
ramya	2	80	36	1.45
ramyadesai	7	15	7	0.28

The following historical commit information, by author, was found:

Author	Rows	Stability	Age	% in comments
2015pushkar	306	82.5	0.2	25.49
Alna	312	52.7	0.3	16.67
Kunal Mozarkar	132	88.6	0.2	2.27
RAJIV ADAK	35	59.3	0.3	0.00
Rekha-csv	677	138.2	0.4	23.49
Shreyasi2059	77	113.2	0.1	2.60
Sourav	289	71.4	0.3	33.22
The-lana	20	71.4	0.1	5.00
aashi291	110	64.3	0.2	19.09
abhaysahu10	4304	96.2	0.4	10.53
ramya	51	63.8	0.1	5.88
ramyadesai	10	66.7	0.1	0.00